SUBSURFACE EXPLORATION AND FOUNDATION RECOMMENDATIONS PROPOSED PUBLIC WORKS BUILDING MATTOON, ILLINOIS

Prepared for:

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SUBSURFACE EXPLORATION AND FOUNDATION RECOMMENDATIONS

PROPOSED PUBLIC WORKS BUILDING FOR CITY OF MATTOON, ILLINOIS

1.0 Introduction

The Upchurch Group is designing a new Public Works Building for the City of Mattoon, Illinois. This report provides a summary of the subsurface exploration and engineering recommendations for foundation and pavement design of the proposed facility. Mr. Mark Dwiggins, Director of Civil Engineering for The Upchurch Group authorized this project on April 1, 2015.

2.0 Scope and Purpose of Report

The purpose of this geotechnical exploration is to explore subsurface conditions at the specific locations of eight soil borings, conduct field and laboratory tests to gather data necessary to perform an evaluation of the subsurface conditions, and prepare engineering recommendations relative to the following items:

- Subsurface conditions encountered in the soil borings, including material types to be expected at existing grades and their impact on the construction scheme.
- Site preparation considerations relative to the subsurface conditions.
- Foundation support of the proposed structure, including acceptable bearing pressures, anticipated bearing levels, and settlement estimates.
- Anticipation and management of ground water during construction.
- Soil material and compaction requirements for support of the proposed building.
- Floor slab support and construction.
- Seismic design recommendations for the proposed structure.

- Presence of mining activity as indicated on the Illinois State Geological Survey underground mine maps.

- Pavement design recommendations for the proposed parking lot and entrance drive.

3.0 Site Description

This site lies in a vacant lot bordered by Lincoln Prairie Grass Trail Road to the south, and Dewitt Avenue to the north in Mattoon. The site is gently sloping, with ground line elevations ranging from about 705 to 710. A drainage ditch bisects the east half of the building site. The trees alongside the ditch were cut prior to our field exploration, and the site was vegetated with grass and weeds. The enclosed Boring Location Diagram indicates the borehole locations at this site in relation to the proposed facility.

4.0 Project Description

This project is to consist of construction of a single story pre-engineered metal building with plan dimensions of about 220 by 150 feet. The building will have a slab on grade, steel frame, and will be used to house and maintain trucks, trailers, and equipment, as well as several public works offices. The structure will be configured as indicated on the enclosed Boring Location Diagram. We estimate maximum wall loadings of about 3 kips per lineal foot, with maximum column loadings of about 100 kips.

5.0 Field Exploration

On May 12, 2015, we drilled six eight borings at this site. Boring locations were staked by The Upchurch Group prior to our arrival on site. Due to access problems caused by the drainage ditch, Borings #3 and #8 were relocated prior to drilling, as indicated on the Boring Location Diagram.

5.1 Drilling and Sampling Procedures

The soil borings were drilled with a CME-750 ATV mounted drilling rig. Conventional 3.25 inch inside diameter hollow stem augers were used to advance the boreholes. Representative soil samples were obtained on 2.5 and 5.0 foot intervals employing split barrel sampling procedures in accordance with ASTM D-1586. Upon completion of drilling, the boreholes were backfilled with the soil cuttings.

5.2 Field Tests and Measurements

The following field tests and measurements were performed during the course of exploration activities at the site:

- Ground water readings were obtained during and upon completion of drilling at all soil boring locations.
- Standard penetration tests were performed and penetration resistances recorded during the recovery of all split barrel samples.
- Approximate measurements of undrained shear strength were taken on all cohesive soil samples with a calibrated hand penetrometer.
- All samples were visually classified according to the Unified Classification System by the boring technician in preparation of the field boring logs. The samples were then placed into glass jars for transport to our laboratory.

The field test data and measurements are summarized in the Boring Logs located in the appendix to this report.

6.0 Laboratory Tests

In addition to the field exploration, a laboratory-testing program was conducted to determine additional engineering characteristics of the foundation subsoils. All tests were performed in accordance with applicable ASTM specifications. The laboratory-testing program included the following tests:

6.1 Natural Moisture Content

Natural moisture content determinations were performed on all samples. Moisture content determinations aid in estimating the settlement potential of a soil strata. The in-situ moistures also yield information as to the workability of a soil type. Moisture content results are graphically presented on the Boring Logs.

6.2 Visual Classifications

All soil samples were visually classified by the geotechnical engineer in accordance with the Unified Classification System. The visual classifications are noted on the Boring Logs.

6.3 Unconfined Compressive Strengths

Cohesive soil samples were subjected to unconfined compressive strength tests. Unconfined compressive strengths are used to determine the shear strength of a soil. Results of the compressive strength tests are plotted on the Boring Logs.

6.4 Sample Disposal

The soil samples are stored in our laboratory for further analysis, if desired. Unless notified to the contrary, the samples will be disposed of six months after the date of this report.

7.0 Subsurface Conditions

The types of subsurface materials encountered in the soil borings are briefly described on the Boring Logs in the appendix to this report. The general characteristics are described in the following paragraphs. The conditions represented by these test borings should be considered applicable only at the test boring locations on the dates shown. It is possible the conditions encountered may be different at other locations or at other times.

7.1 General Subsurface Profile

The subsurface profile at this site consists of about six to eight inches of topsoil overlying eight to eleven feet of gray mottled brown to brown mottled gray silty clay (CL), sand (SP), and sandy silt (ML). Below the upper clay, sand and silt lies a gray silty clay (CL) with sand and pebbles glacial till that extends down to at least the bottom of the deeper soil borings.

7.2 Topsoil

The topsoil is an organic deposit, with roots and humus. This stratum will become highly compressible upon decay of the organic material. The topsoil is not considered suitable for support of the footings, fills, slabs, or pavements at this site.

7.3 Soft Silty Clay

Soft deposits of silty clay were encountered in the upper three to six feet of this site. The following borings encountered marginal subsoils at the corresponding depths:

Boring No.	Extent of Soft Soil (ft.)
1	0-3'
2	3-6'
3	3-6'
5	3-6'
6	3-5'
8	3-6'

These soils have unconfined compressive strengths of 0.2 to 0.6 tons per square foot, averaging 0.4 tsf. Standard penetration test values range from 3 to 5 blows per foot, averaging 4 bpf. Moisture contents vary from 20 to 35 percent, averaging 26 percent. These soils have a relatively high settlement potential.

7.4 Stiff Silty Clay

The upper silty clay outside of the soft areas noted in Section 7.3 of this report is stiff, with unconfined compressive strengths ranging from 0.9 to 2.2 tons per square foot, averaging 1.5 tsf. Standard penetration test values of 4 to 10 blows per foot were encountered in these soils, averaging about 7 blows per foot. Moisture contents vary from 13 to 29 percent, averaging 21 percent. These soils have a moderate to low settlement potential.

7.5 Silty Clay Glacial Till

The silty clay glacial till stratum is very dense, with unconfined compressive strength tests ranging from 1.6 to 8.5 tons per square foot, averaging 2.7 tsf. Moisture contents vary from 10 to 15 percent, averaging 13 percent. The glacial till has a very low settlement potential.

7.6 Ground Water

Free water was encountered at depths ranging from 6 to 8.5 feet in the soil borings. The shallow soil borings were dry during and upon completion of drilling operations.

7.7 Undermining

Maps available from the Illinois State Geological Survey indicate this site is not undermined. Therefore, mine subsidence is not a concern at this location.

8.0 Grading Considerations

8.1 Site Preparation

The drainage ditch bisecting the site was cleared of brush and trees prior to our field exploration. However, there are stumps and trees laying on the ground in this area. The stumps should be excavated, and all vegetation removed from the building pad and parking lot/drive areas. The topsoil may be used to grade landscaped areas of this site, or wasted.

After removal of the topsoil, the drainage ditch should be cleaned out by removing all soft, saturated soils down to stiff subsoils. The side banks of the ditch should be excavated as well back to stiff subsoils. A representative of the geotechnical engineer can delineate the overexcavation with a hand held probe during removal of the unsuitable soils.

After the topsoil is stripped and ditch cleaned out, the exposed subgrade in the building pad, drive, and parking lot should be proofrolled with a loaded tandem dump truck. During proofrolling operations, areas that pump or rut should either be disced and aerated, or excavated from the site and replaced. Any disturbed or pumping soils should be properly compacted prior to placement of fill soils or building construction.

Due to the high silt content of the upper soils, if at all possible the site grading should be performed during hot, dry months of the year. If site grading is performed when the soils are wet, the subgrade may pump to such a degree that it may have to be removed and replaced, or require the addition of hydrated lime for drying prior to compaction.

8.2 Fill Placement

After proofroll of subsoils in the building and areas to be paved, fill soils may be placed to grade the building pad and parking lot areas. The low plastic silty clay soils encountered in the soil borings should provide acceptable fill for the building pad and drives. It is recommended the fill soils are placed in maximum eight inch loose lifts, with each lift compacted to a minimum of 98% of the maximum standard laboratory dry density *below* any proposed footing elevations, and 95% compaction *above* the footing elevations.

The drainage ditch will have a 15 inch diameter storm sewer pipe installed to carry the water below the building. The pipe should be properly backfilled, since the building foundations will be supported on the pipe and fill material.

A sufficient number of in-place field density tests should be performed by an engineering technician to evaluate the contractor's performance during fill soil placement and compaction. The tests will also aid in determining whether project specifications are being met. A minimum of four compaction tests per every lift are recommended, with not less than one test per 5,000 square feet of fill soil placed.

8.3 Subgrade Preparation of Floor Slabs

Environmental conditions and construction traffic often disturb even a well-prepared soil surface at the final grade elevation. Provisions should be made in the construction specifications for the contractor to restore the subgrade soils to a stable condition prior to placing the granular mat. Backfilling of utility trenches is often accomplished in an uncontrolled manner, leading to cracking of floor slabs and pavements. We recommend the utility trenches be backfilled with acceptable fill in eight inch loose lifts and compacted with piston tampers to the project requirements.

The concrete floor slab may be supported upon a four-inch layer of free draining granular material. Generally, Illinois Department of Transportation Type "A" CA-7 or CA-11 crushed limestone is used in Illinois for this purpose. This is to provide a capillary break and a uniform leveling course beneath the slab.

8.4 Ground Water Control

During preparation of the subgrade near the existing ground surface, ground water is not anticipated. However, if free water is encountered in the footing excavations or drainage ditch, the contractor should make provisions for temporary drainage through the use of sumps and/or interceptor ditches.

9.0 Engineering Recommendations

9.1 Building Foundations

Based upon results of the field and laboratory tests, the proposed structure may be supported upon shallow foundations consisting of isolated column and continuous wall footings. A maximum net allowable soil bearing pressure of up to 2200 pounds per square foot may be used to dimension the footings if the foundation subsoils are tested as follows:

- Excavate the footings to the recommended bottom of foundation elevation.
- Probe each footing excavation to a minimum depth of 2.5 feet below the footing bottom elevation with a calibrated penetrometer.
- Excavate any soft or unsuitable soils below the footings and replace with a well compacted crushed limestone, lean concrete or flowable fill material.

This procedure is necessary due to the marginal subsoils encountered in the upper elevations of the soil borings at this site. The borings indicate several locations will require undercut and replacement.

The exterior footings should be founded at a minimum depth of 3.0 feet for frost protection. Interior footings in heated areas may be founded at one foot below the final subgrade elevation. It is also recommended all footings have a minimum width of 24 inches to avoid a punching type failure of the foundation.

Total settlements of a 100 kip column are estimated to range from approximately 0.5 to 1.1 inch, with differential settlements of about 0.5 inch. To minimize settlements, it is extremely important the soft subsoils below the footings are excavated and replaced prior to placement of concrete.

9.2 Seismic Design

Based upon the seismic design criteria provided by the I.B.C., this site has a site classification type "E" profile. Based upon this profile, the spectral response acceleration coefficients have been determined as follows:

0.2 Second Period: S_{ms} = 0.284 g x 2.391 (Soil Factor F_a) = 0.679

1.0 Second Period: S_{m1} = 0.123 g x 3.447 (Soil Factor F_v) = 0.424

The recommended design spectral response factors are as follows:

S_{DS} = 0.453 g

S_{D1} = 0.282 g

These values were obtained from the IBC Section 1615 and the USGS Earthquake Hazards Program based upon the latitude and longitude of this site.

9.3 Retaining Wall Design

Coefficients for active and passive pressures acting upon retaining walls in the upper ten feet of this site are estimated as follows:

Coefficient of Active Pressure:	0.35
Coefficient of Passive Pressure:	2.75
Coefficient of At-Rest Pressure:	0.53

The silty clay and sandy clay subsoils encountered on this site have a wet soil density of approximately 125 pounds per cubic foot. It is recommended the retaining walls are backfilled with free draining sand or crushed stone up to within one foot of the final ground line, with perforated PVC pipe at the base of the wall sloped to gravity drain or drain to a sump.

The recommended coefficient of friction between the concrete and soils that may be used for design is 0.33.

9.4 Floor Slab Design

The proposed concrete slab on grade may be designed using a modulus of subgrade reaction estimated at approximately 100 psi per inch. The soil subgrade beneath the slab should be properly proofrolled or compacted per the recommendations in Section 8 of this report.

10.0 Pavement Design

The following pavement designs are based upon an estimated Illinois bearing ratio of 2.0 for the soil subgrade, and the subgrade being compacted to a minimum of 95% of the maximum standard laboratory dry density. The designs have been determined using the IDOT "Flexible Pavement Design Manual" (August 31, 1988). Recommended pavement designs are as follows:

10.1 Automobile Parking Lot Pavement

Traffic Loadings:	500 Passenger Cars/Day
Design Life:	20 Years
Illinois Bearing Ratio:	2.0

Pavement Design - Automobile Parking Lots

Bituminous Concrete Surface:	2.0"
CA-06 Basecourse:	8.0"

10.2 Heavy Duty Pavement (Truck Drives)

Traffic Loadings:	500 Passenger Cars/Day
	5 Single Unit Trucks
	1 Semi or Trash Truck
Design Life:	20 Years
Illinois Bearing Ratio:	2.0

Pavement Design - Heavy Duty Pavement

Bituminous Concrete Surface:	1.5"
Bituminous Concrete Binder:	2.0"
CA-06 Basecourse:	10.0"

Or

Portland Cement Concrete:	7.0"
Granular Subbase, Type A:	4.0"

Due to the heavy point loadings of steel dumpster wheels, the dumpster storage areas should be paved with Portland Cement Concrete.

The Illinois Department of Transportation "Standard Specifications for Road and Bridge Construction" adopted on January 1, 2012 indicates the materials to be used in the following sections:

Bituminous Concrete Surface and Binder
Section 406 (Pages 196-210)

Portland Cement Concrete
Section 420 (Pages 226-242)

Crushed Stone Basecourse
Section 351 (Pages 168-171)

Granular Subbase, Type A
Section 311 (Pages 149-153)

11.0 Summary

This subsurface exploration has been conducted at the site of the proposed Public Works Building in Mattoon, Illinois. This report has been prepared for the exclusive use of The Upchurch Group for the specific application to this project.

Design and construction criteria have been suggested and potential problems have been discussed.

The following information has been discussed in this report:

- Soils encountered on the site consist of a thin mantle of topsoil overlying 8 to 11 feet of brown silty clay, sand, and sandy silt. Below the silty clay lies gray sandy clay glacial till that extends down to at least the bottom of the soil borings.

- Site grading will include stripping the topsoil, mucking out the drainage ditch, proofrolling the exposed subgrade, and placement of fill to grade the building pad and drives.

- Foundation design criteria have been discussed, and allowable soil bearing pressures have been recommended for shallow foundations.

- The shallow foundations may be dimensioned using a maximum allowable soil bearing pressure of up to 2200 pounds per square foot if the foundation soils are probed to at least 2.5 feet below the existing ground line with any soft subsoils excavated and replaced.

- The subsoils in the upper five to six feet of this site have marginal strengths, and may require undercut if encountered in the footing excavations.

- Mine maps indicate this site has not been undermined.

- The International Building Code indicates this site has a type "D" site classification, based upon the soil borings. The recommended design spectral response factors for this site are S_{DS} = 0.453 g and S_{D1} = 0.282 g.

- Pavement design recommendations have been presented for light and heavy duty pavement loadings.

The analyses, conclusions, and recommendations contained in this report are professional opinions based on the site conditions and project scope described herein. It is assumed the conditions observed in the exploratory borings are representative of subsurface conditions throughout the site. If during construction, subsurface conditions differ from those encountered in the exploratory borings are observed or appear to be present beneath excavations, we should be advised at once so that we can review these conditions and reconsider our recommendations where necessary. Unless specifically noted, the scope of our services did not include an assessment of the effects of flooding and natural erosion of creeks or rivers adjacent to the project site.

If there is a substantial lapse in time between the submittal of this report and the start of work at this site, or if site conditions are changed due to natural causes or construction operations, we recommend that this report be reviewed to determine the applicability of conclusions and recommendations considering the changed conditions and time lapse.

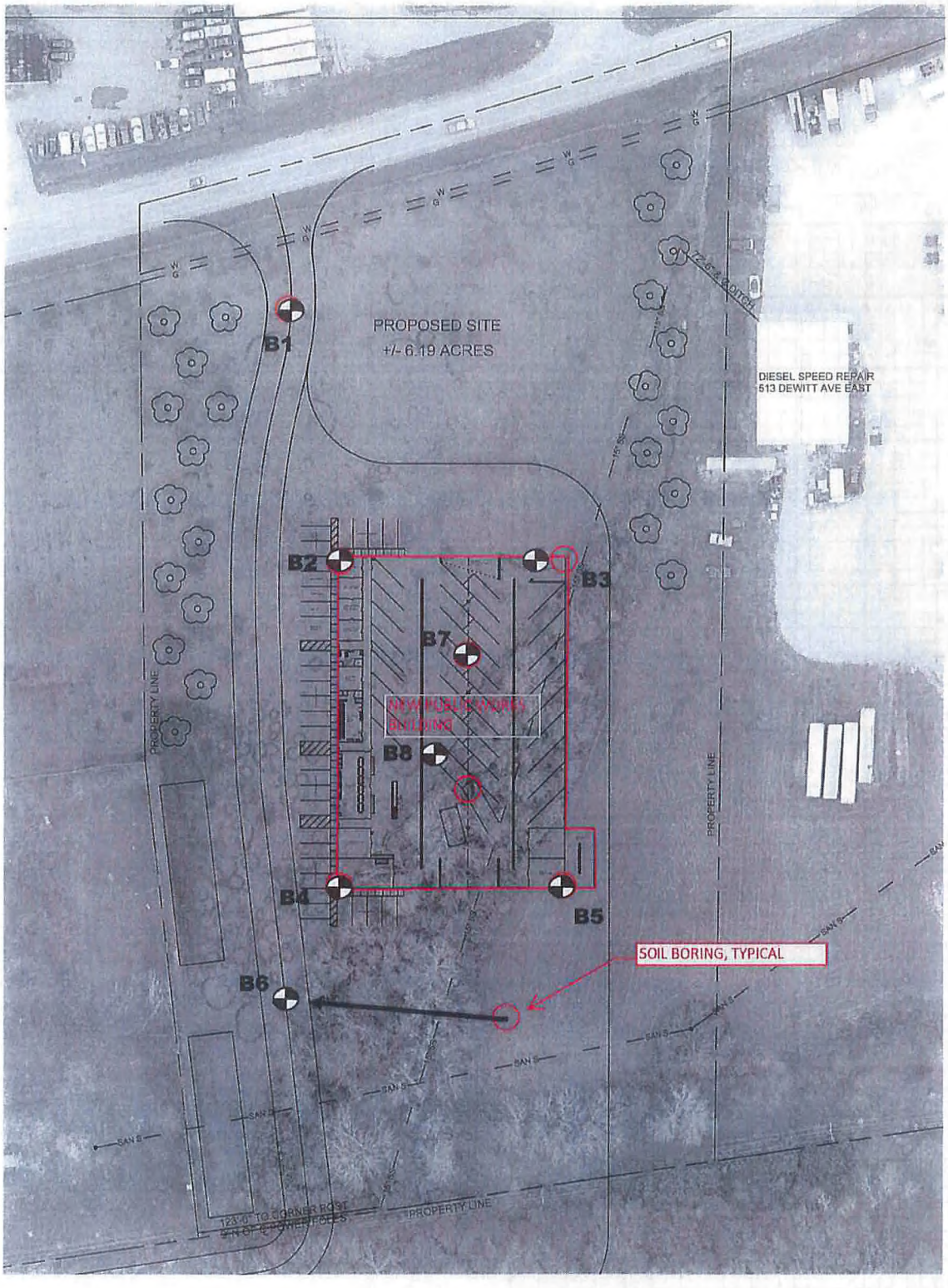
In order for us to provide a complete professional geotechnical engineering service, we should be retained to observe construction, particularly site grading, earthwork and foundation construction.

The scope of our services for this phase of the project does not include any environmental assessment or investigation for the presence or absence of wetlands or hazardous or toxic material in the soil, surface or ground water or air, on or below this site. Any statements in this report or on the boring logs regarding any odors or unusual or suspicious items or conditions observed are strictly for the information of our client.

This report was prepared for the exclusive use of the owner, architect, or engineer for evaluating the design of the project as it relates to the geotechnical aspects discussed herein. It should be made available to prospective contractors for information on factual data only and not as a warranty of subsurface conditions included in this report. Unanticipated soil conditions or rock may require that additional expense be made to attain a properly constructed project. Therefore, some contingency fund is recommended to accommodate such potential extra costs.

It is recommended that we be retained to review final project layout and those portions of plans and specifications which pertain to foundations and earthwork to determine if they are consistent with our findings and recommendations.

Timothy J. Holcomb, P.E.



Project: **Proposed Public Works Building** **Mattoon, Illinois** ***Client:*** **The Upchurch Group** **Mattoon, Illinois**	**Boring Location Diagram**	**Project No. H-15082** North **Not to Scale** **May 12, 2015**

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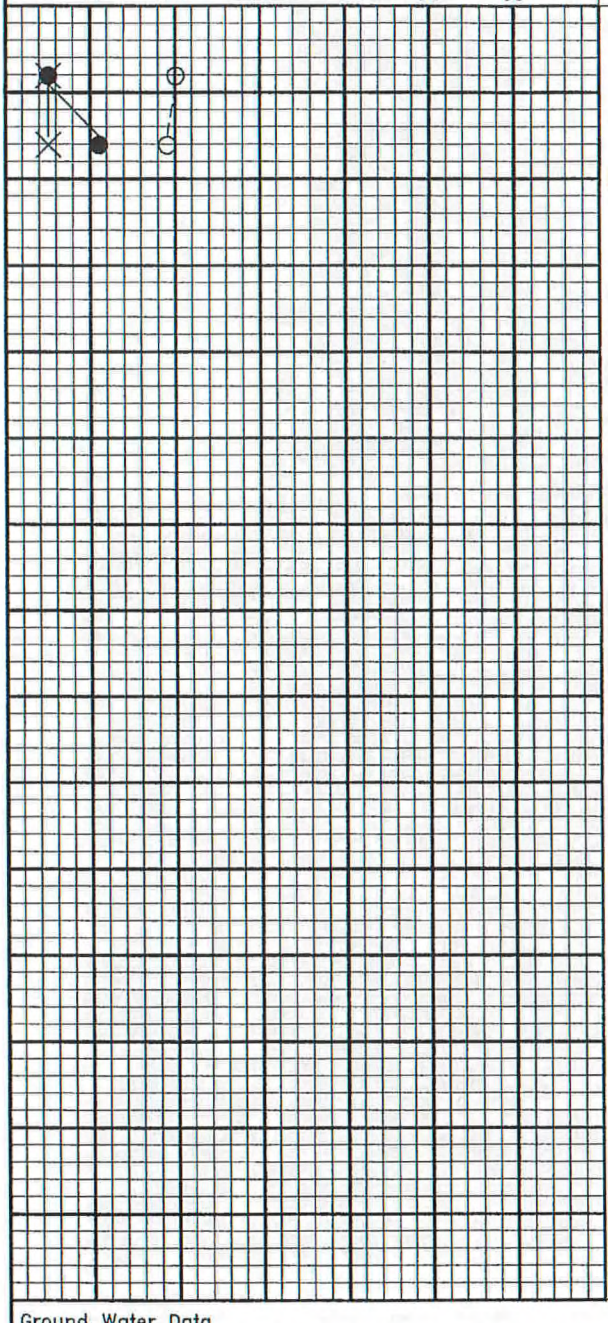
LOG of BORING 1

Unconfined Compressive Strength (Tons/Sq. Ft.)
1 2 3 4 5 6

Water Content (%)

Standard N Penetration, Blows/Ft.
10 20 30 40 50 60



Depth in Feet	Sample No.	Type Sample	Sample Distance	Description of Material
				Surface Elevation **707.6**
				7" Topsoil
	1	ss		Brown Sandy CLAY (CL)
	2	ss		Brown Mottled Gray Silty CLAY (CL)
5				End of Boring @ −5.0'

Ground Water Data
No Ground Water Encountered During Drilling.

Project: **Proposed Public Works Building**
Mattoon, Illinois

Date of Boring
May 12, 2015

Client: **The Upchurch Group**
Mattoon, Illinois

Project No.
H−15082

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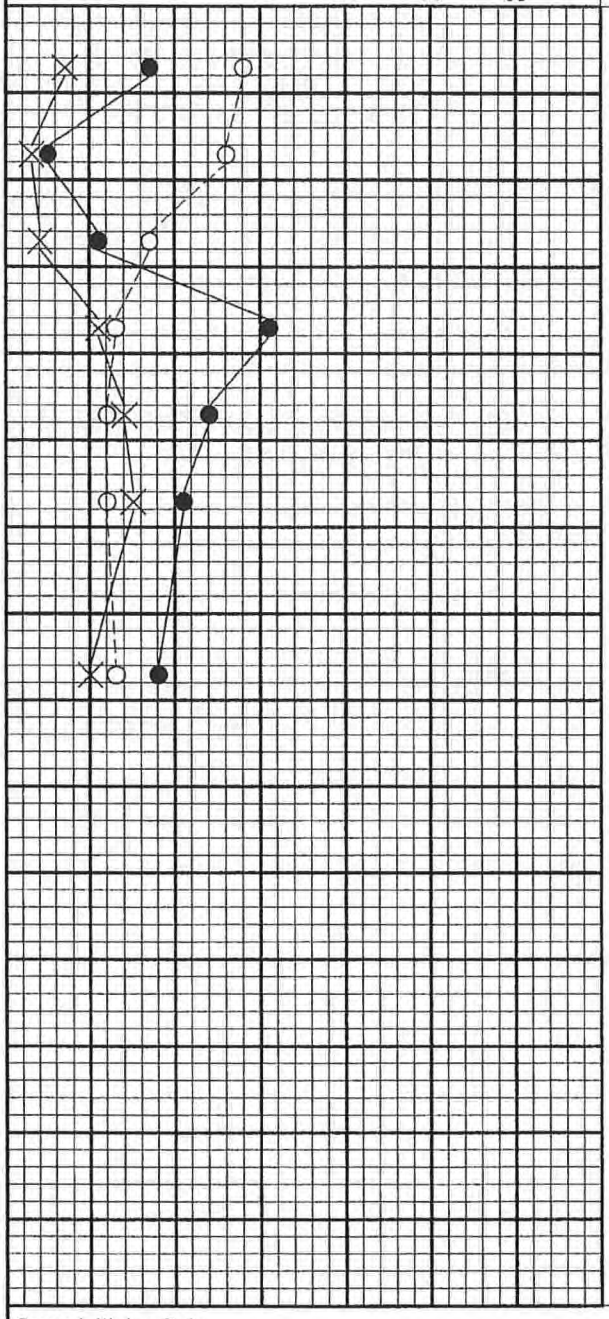
LOG of BORING 2



Depth in Feet	Sample No.	Type Sample	Sample Distance	Description of Material
				Surface Elevation **705.9**
				6" Topsoil
	1	ss		Gray Mottled Brown Silty CLAY (CL)
	2	ss		
5				
	3	ss		Brown Mottled Gray Silty CLAY (CL)
	4	ss		Gray Silty CLAY (CL) with sand and pebbles
10				
	5	ss		
	6	ss		
15				
	7	ss		
20				End of Boring @-20.0'
25				
30				
35				

Ground Water Data
Ground Water Encountered @ -8.5' During Drilling and @ -3.0' Upon Completion.

Project: **Proposed Public Works Building** **Mattoon, Illinois**	**Date of Boring** **May 12, 2015**
Client: **The Upchurch Group** **Mattoon, Illinois**	**Project No.** **H-15082**

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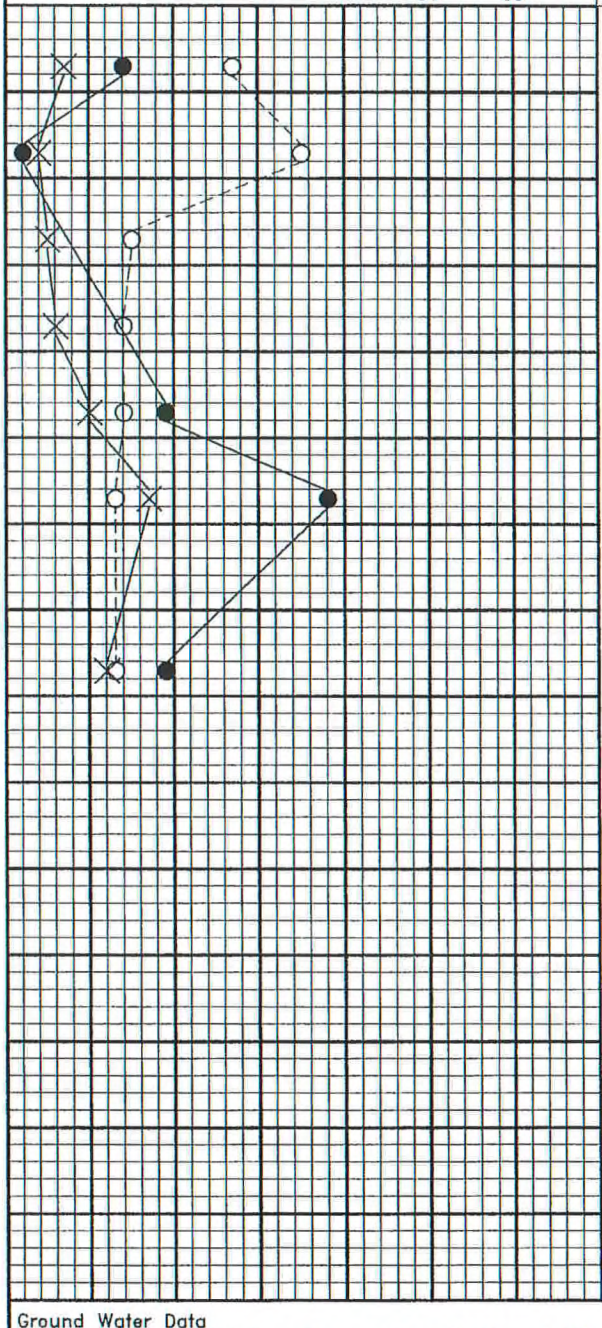
LOG of BORING 3



Depth in Feet	Sample No.	Type Sample	Sample Distance	Description of Material
				Surface Elevation **705.1**
				6" Topsoil
	1	ss		Gray Mottled Brown to Brown Mottled Gray Silty CLAY (CL) with trace sand
	2	ss		
5	3	ss		Gray SAND (SP) with gravel
	4	ss		
10	5	ss		Gray Silty CLAY (CL) with sand and pebbles
	6	ss		
15				
	7	ss		
20				End of Boring @ −20.0'
25				
30				
35				

Ground Water Data
Ground Water Encountered @ −6.0' During Drilling and Plugged Upon Completion.

Project: **Proposed Public Works Building** **Mattoon, Illinois**	**Date of Boring** **May 12, 2015**
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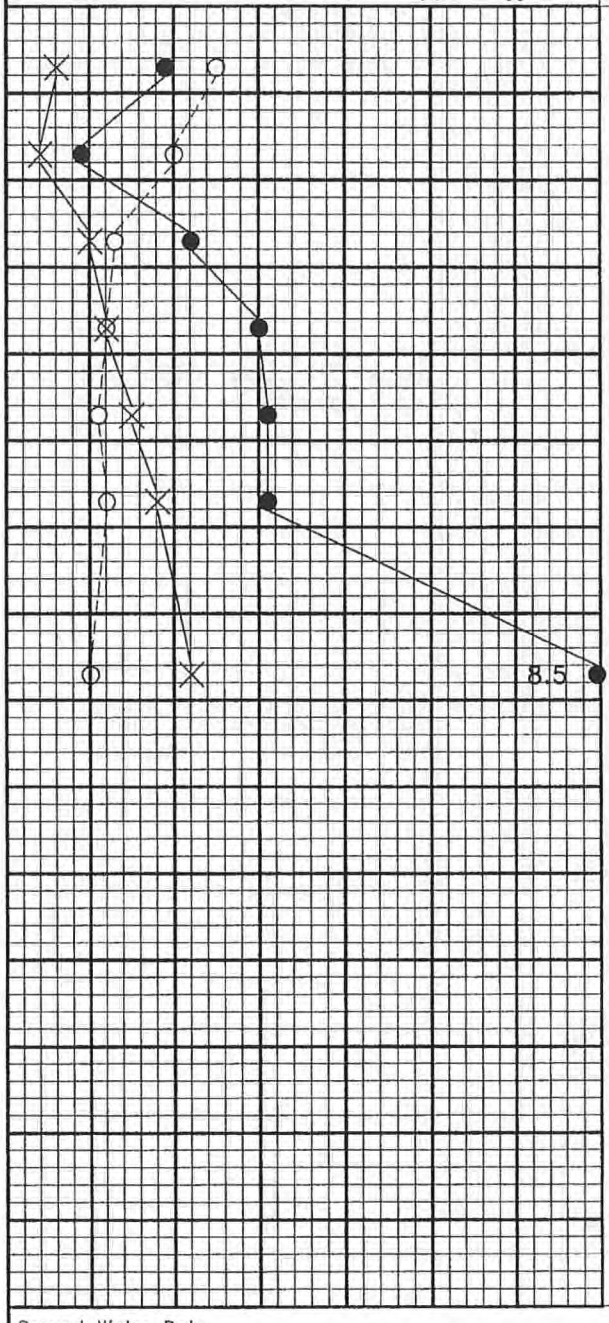
LOG of BORING 4



Depth in Feet	Sample No.	Type Sample	Sample Distance	Description of Material
				Surface Elevation **706.9**
				8" Topsoil
	1	ss		Gray Mottled Brown to Brown Mottled Gray Silty CLAY (CL)
5	2	ss		
	3	ss		Brown Silty CLAY (CL) with sand
	4	ss		Gray Silty CLAY (CL) with sand and pebbles
10	5	ss		
	6	ss		
15				
	7	ss		
20				End of Boring @ −20.0'
25				
30				
35				

Ground Water Data
Ground Water Encountered @ −6.0' During Drilling and Plugged Upon Completion.

Project: **Proposed Public Works Building** **Mattoon, Illinois**	**Date of Boring** **May 12, 2015**
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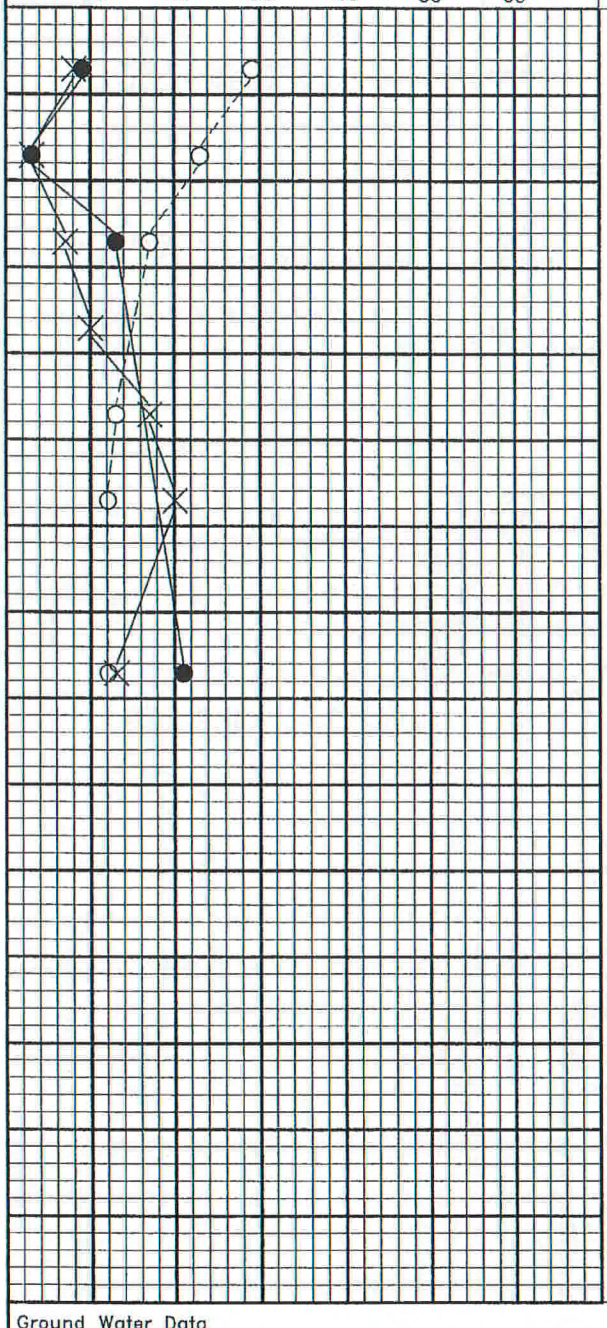
LOG of BORING 5



Depth in Feet	Sample No.	Type Sample	Sample Distance	Description of Material
				Surface Elevation **709.2**
				8" Topsoil
	1	ss		Brown Mottled Gray Silty CLAY (CL)
5	2	ss		
	3	ss		
	4	ss		
10				Gray Silty CLAY (CL) with sand and pebbles
	5	ss		
	6	ss		
15				
	7	ss		
20				End of Boring @ −20.0'
25				
30				
35				

Ground Water Data
Ground Water Encountered @ −6.0' During Drilling and Plugged Upon Completion.

Project: **Proposed Public Works Building** **Mattoon, Illinois**	**Date of Boring** **May 12, 2015**
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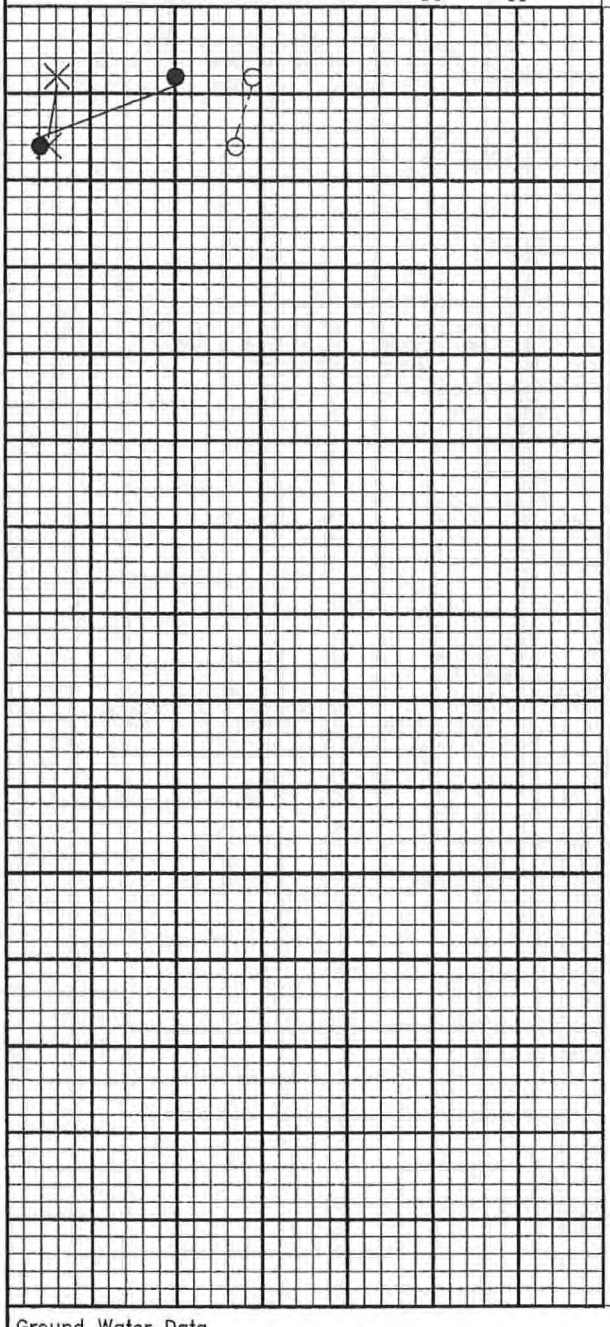
LOG of BORING 6



Depth in Feet	Sample No.	Type Sample	Sample Distance	Description of Material
				Surface Elevation **708.5**
				8" Topsoil
	1	ss		Gray Mottled Brown Silty CLAY (CL)
	2	ss		
5				End of Boring @ −5.0'

Ground Water Data
No Ground Water Encountered During Drilling.

Project: **Proposed Public Works Building** **Mattoon, Illinois**	**Date of Boring** **May 12, 2015**
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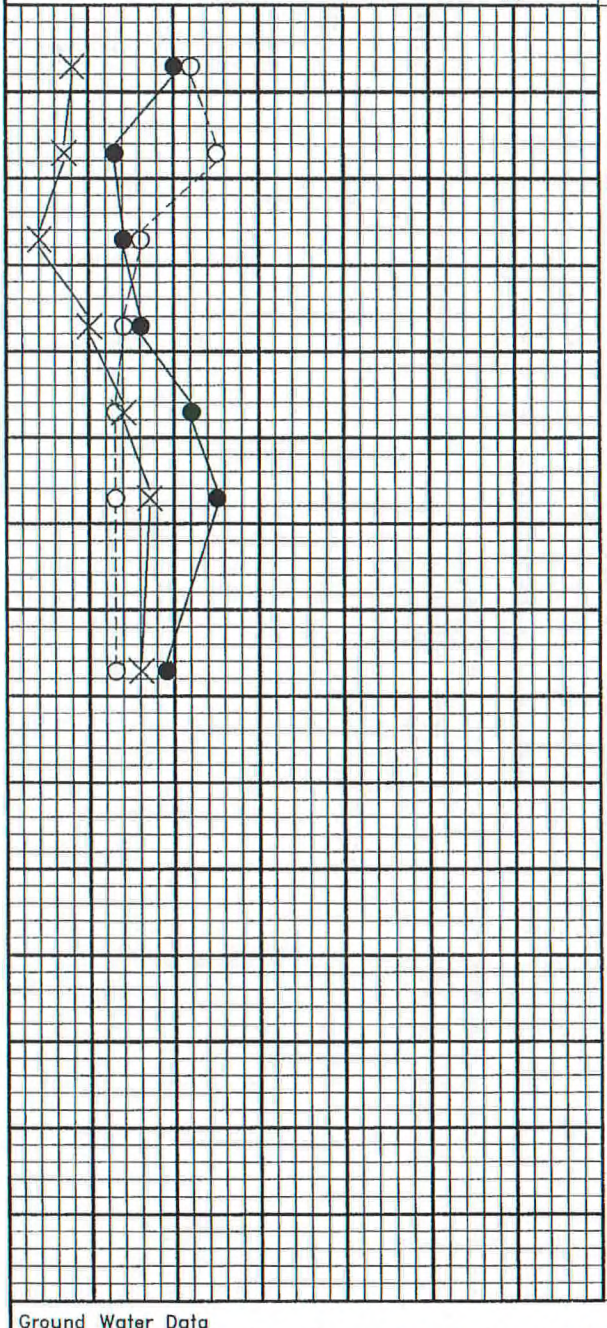
LOG of BORING 7



Depth in Feet	Sample No.	Type Sample	Sample Distance	Description of Material
				Surface Elevation
				6" Topsoil
	1	ss		Gray Mottled Brown to Brown Mottled Gray Silty CLAY (CL)
5	2	ss		
	4	ss		
	4	ss		Gray Silty CLAY (CL) with sand and pebbles
10	5	ss		
	6	ss		
15				
	7	ss		
20				End of Boring @ −20.0'
25				
30				
35				

Ground Water Data
Ground Water Encountered @ −8.5' During Drilling and Plugged Upon Completion.

Project: **Proposed Public Works Building** **Mattoon, Illinois**	**Date of Boring** **May 12, 2015**
Client: **The Upchurch Group** **Mattoon, Illinois**	**Project No.** **H−15082**

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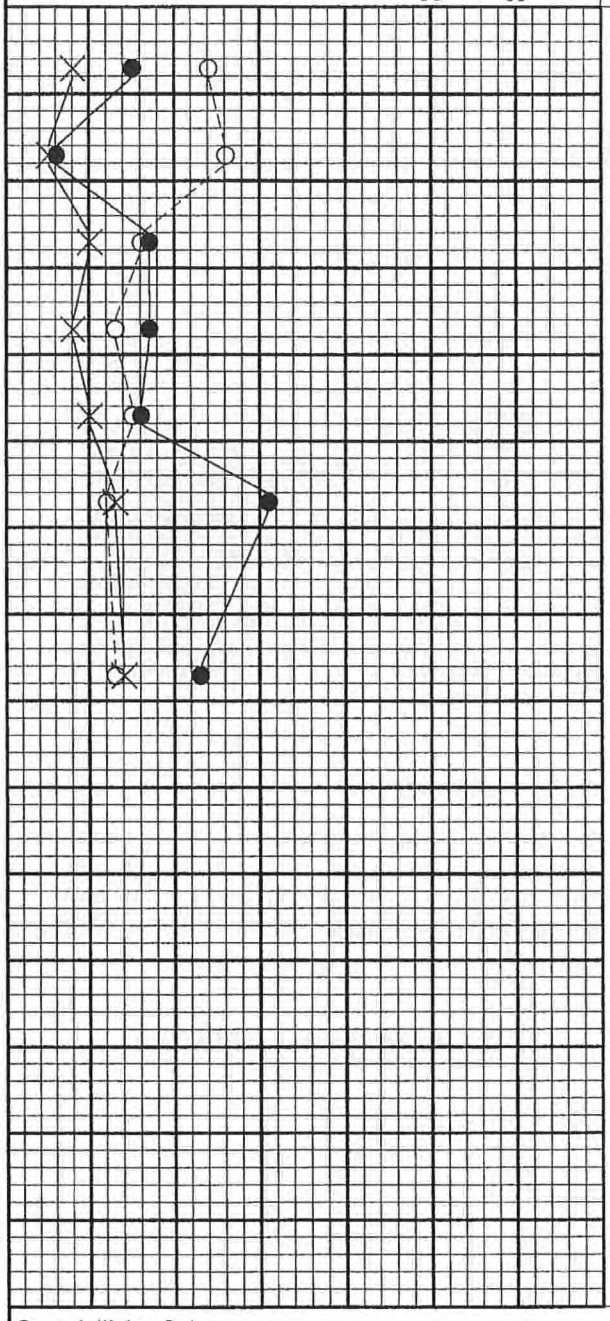
LOG of BORING 8



Depth in Feet	Sample No.	Type Sample	Sample Distance	Description of Material
				Surface Elevation
				8" Topsoil
	1	ss		Gray Mottled Brown to Brown Mottled Gray Silty CLAY (CL)
5	2	ss		
	3	ss		Gray Sandy CLAY to Sandy SILT (CL–ML)
	4	ss		Brown Silty CLAY (CL) with sand
10	5	ss		Gray Silty CLAY (CL) with sand and pebbles
15	6	ss		
	7	ss		
20				End of Boring @ –20.0'
25				
30				
35				

Ground Water Data
Ground Water Encountered @ –6.0' During Drilling and Plugged Upon Completion.

Project: **Proposed Public Works Building** **Mattoon, Illinois**	**Date of Boring** **May 12, 2015**
Client: **The Upchurch Group** **Mattoon, Illinois**	**Project No.** **H–15082**

USGS Design Maps Summary Report

User-Specified Input

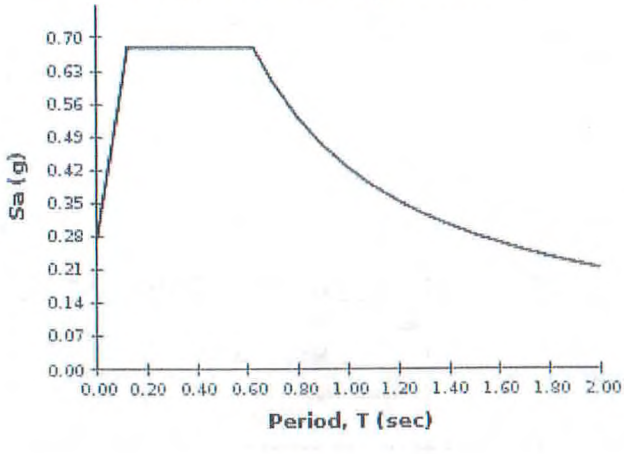
Report Title	Mattoon PWB Wed May 20, 2015 19:39:02 UTC
Building Code Reference Document	2012 International Building Code (which utilizes USGS hazard data available in 2008)
Site Coordinates	39.48885°N, 88.34389°W
Site Soil Classification	Site Class E – "Soft Clay Soil"
Risk Category	I/II/III

USGS-Provided Output

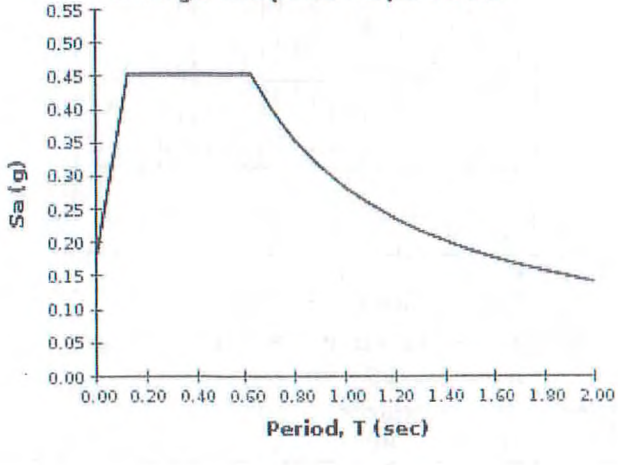
S_S =	0.284 g	S_{MS} =	0.679 g	S_{DS} =	0.453 g
S_1 =	0.123 g	S_{M1} =	0.424 g	S_{D1} =	0.282 g

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.

MCE_R Response Spectrum



Design Response Spectrum



GENERAL NOTES

SAMPLE INDENTIFICATION

The Unified Classification System is used to indentify the soil unless othwerwise noted.

RELATIVE DENSITY & CONSISTENCY CLASSIFICATION

TERM (NON-COHESIVE SOILS)	BLOWS PER FOOT
Very Loose	0-4
Loose	5-10
Firm	11-30
Dense	31-50
Very Dense	Over 50

TERM (COHESIVE SOILS)	QU (tsf)
Very Soft	0.00- 0.25
Soft	0.25-0.50
Firm	0.50-1.00
Stiff	1.00-2.00
Very Stiff	2.00-4.00
Hard	4.00+

DRILLING & SAMPLING SYMBOLS

ss:	Split Spoon-	1 3/8" I.D., 2" O.D.
st:	Shelby Tube-	2.80" I.D., 3" O.D.
au:	Auger Samples	
cs:	Continuous Sampling	2.0" I.D

SOIL PROPERTY SYMBOLS

●	Unconfined Compressive Strength, Qu (tsf)
+	Penetrometer Value, (tsf)
	Plastic Limit (%)
o	Water Content (%)
	Liquid Limit (%)
x	Standard "N" Penetration: Blows per foot of a 140 pound hammer falling 30 inches on a 2" O.D. Split Spoon

PARTICLE SIZE

Boulders	8in +	Medium Sand	0.6mm to 0.2mm
Cobbles	8in to 3in	Fine Sand	0.2mm to 0.74 mm
Gravel	3in. to 5mm	Silt	0.074mm to 0.0005mm
Coarse Sand	5mm to 0.6mm	Clay	Less Than 0.005mm

UNIFIED SOIL CLASSIFICATIONS

MAJOR DIVISIONS			SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS	GW	Well graded gravels, gravel-sand mixtures
			GP	Poorly graded gravels, gravel-sand mixtures
		GRAVELS WITH FINES	GM	Silty gravels, gravel-sand silt mixtures
			GC	Clayey gravels, gravel-sand clay mixtures
	SANDS AND SANDY SOILS	CLEAN SANDS	SW	Well-graded sands, gravelly sands
			SP	Poorly graded sands, gravelly sands
		SANDS WITH FINES	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, clay-sand mixtures
FINE GRAINED SOILS	SILTS AND CLAYS LOW PLASTICITY		ML	Inorganic silts of clayey silts with slight plasticity
			CL	Inorganic clays of low to medium plasticity
			OL	Organic silts and organic silty clays of low plasticity
	SILTS AND CLAYS HIGH PLASTICITY		MH	Inorganic silts of high plasticity
			CH	Inorganic clays of high plasticity
			OH	Organic clays of medium to high plasticity
HIGHLY ORGANIC SOILS			PT	Peat, humus, swamp soils with high organic contents